GCB Bioenergy 2017

Carbon sequestration and turnover in soil under the energy crop Miscanthus: Repeated ^{13}C natural abundance approach and literature synthesis

Zang H., Blagodatskaya E., Wen Y., Xu X., Dyckmans J., Kuzyakov Y.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2017 John Wiley & Sons Ltd. The stability and turnover of soil organic matter (SOM) are a very important but poorly understood part of carbon (C) cycling. Conversion of C 3 grassland to the C 4 energy crop Miscanthus provides an ideal opportunity to quantify medium-term SOM dynamics without disturbance (e.g., plowing), due to the natural shift in the δ 13 C signature of soil C. For the first time, we used a repeated 13 C natural abundance approach to measure C turnover in a loamy Gleyic Cambisol after 9 and 21 years of Miscanthus cultivation. This is the longest C 3 -C 4 vegetation change study on C turnover in soil under energy crops. SOM stocks under Miscanthus and reference grassland were similar down to 1 m depth. However, both increased between 9 and 21 years from 105 to 140 mg C ha -1 ($P < 0.05$), indicating nonsteady state of SOM. This calls for caution when estimating SOM turnover based on a single sampling. The mean residence time (MRT) of old C (> 9 years) increased with depth from 19 years (0-10 cm) to 30-152 years (10-50 cm), and remained stable below 50 cm. From 41 literature observations, the average SOM increase after conversion from cropland or grassland to Miscanthus was 6.4 and 0.4 mg C ha -1 , respectively. The MRT of total C in topsoil under Miscanthus remained stable at ~60 years, independent of plantation age, corroborating the idea that C dynamics are dominated by recycling processes rather than by C stabilization. In conclusion, growing Miscanthus on C-poor arable soils caused immediate C sequestration because of higher C input and decreased SOM decomposition. However, after replacing grasslands with Miscanthus, SOM stocks remained stable and the MRT of old C 3 -C increased strongly with depth.

http://dx.doi.org/10.1111/gcbb.12485

Keywords

13 C natural abundance, C -C vegetation change 3 4, Carbon sequestration, Energy crop, Mean residence time, Soil organic matter